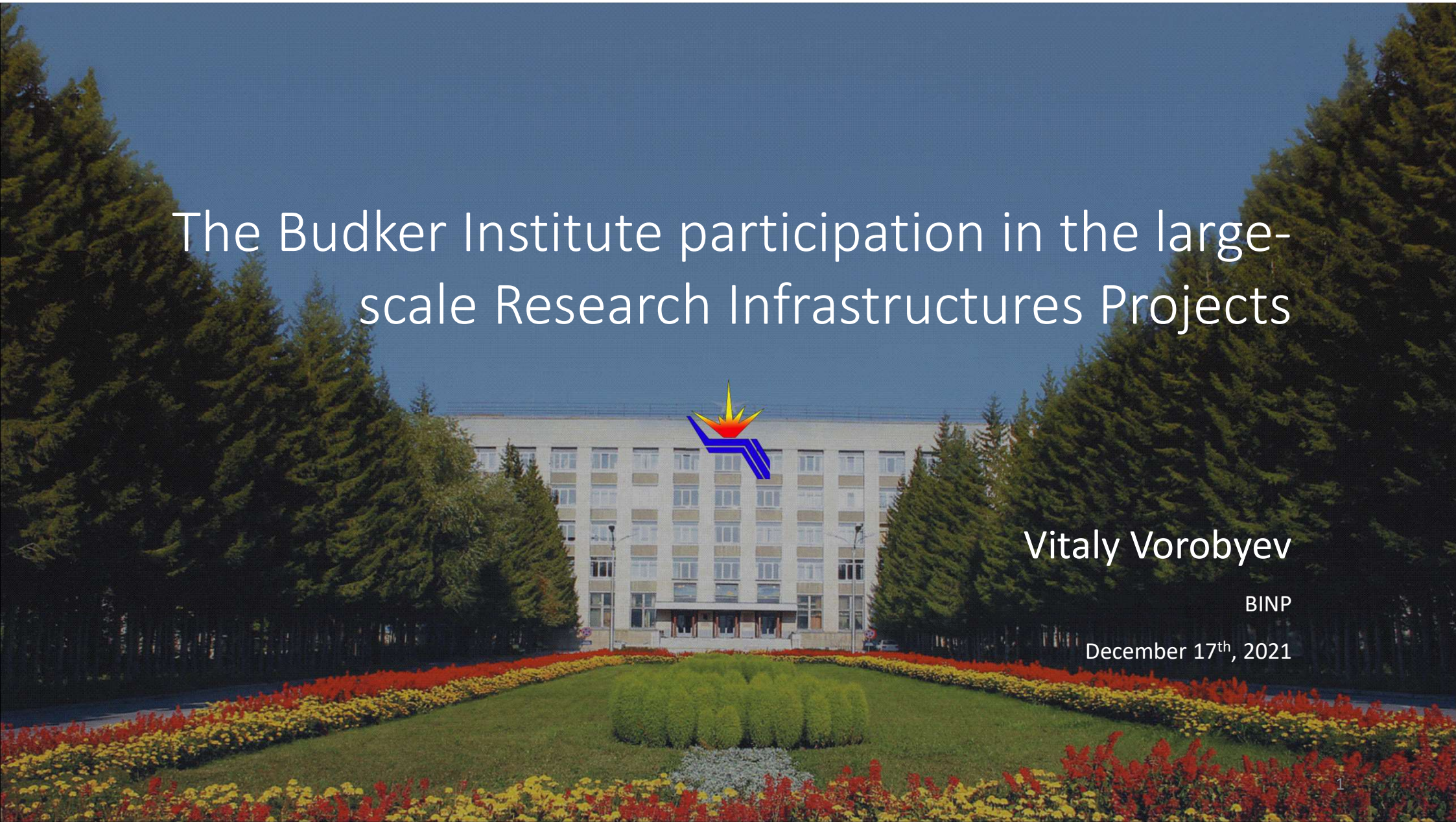


# The Budker Institute participation in the large-scale Research Infrastructures Projects

Vitaly Vorobyev

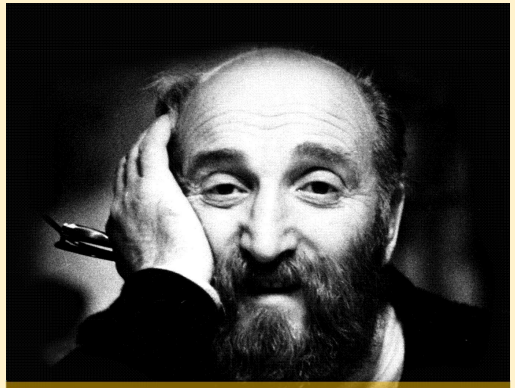
BINP

December 17th, 2021

# BINP Overview

- Location: Novosibirsk, Russia
- Main research areas:
  1. High energy physics: experiments KEDR, CMD-3, SND
  2. Physics and technology of $e^+e^-$ colliders: injection complex VEPP-5, colliders VEPP-2000 and VEPP-4M
  3. Synchrotron radiation and free electron laser (FEL)
  4. Fusion research: GOL and GDL facilities
- Other activities:
  5. Industrial accelerators
  6. Physics for medicine and safety
  7. Theoretical physics
  8. Participating in International collaborations: CERN, DESY, Frascati LNF, Fermilab, SLAC, KEK, …

- BINP was found in 1958 by Gersh Budker
- About 2900 employers in 2021:
  - 1230 in scientific laboratories
  - 700 in experimental workshop
  - 220 in administration
  - 750 in services

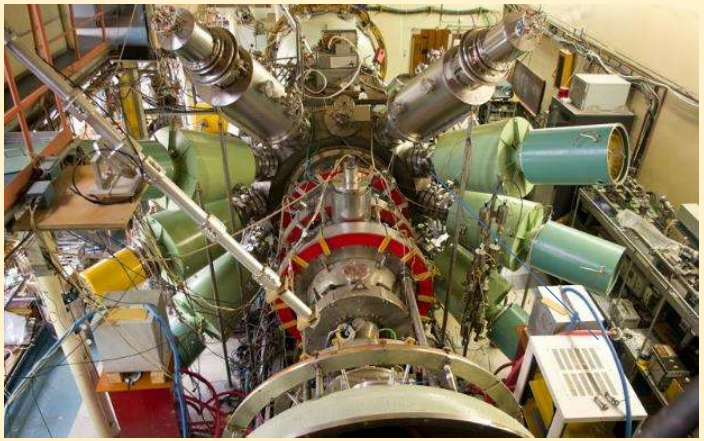


Gersh Budker (1918-1977)

BINP scientific council – “The Round Table”

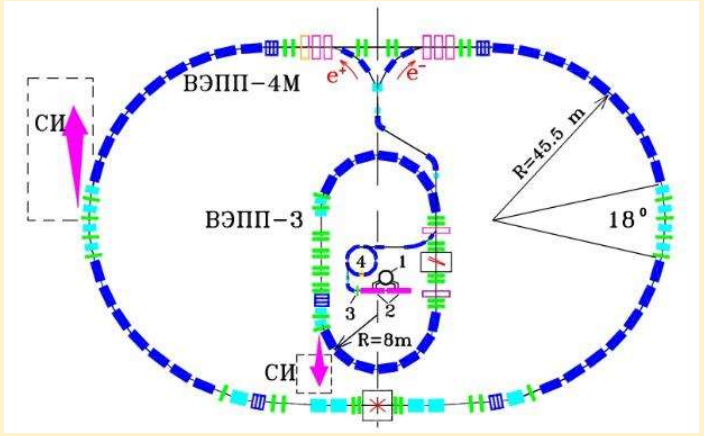
Pavel Logachev, BINP director since 2015

# LIST-11 facilities at BINP



+ Complex of Long Open Traps

+ Complex of $e^+e^-$ colliders VEPP-4M and VEPP-2000

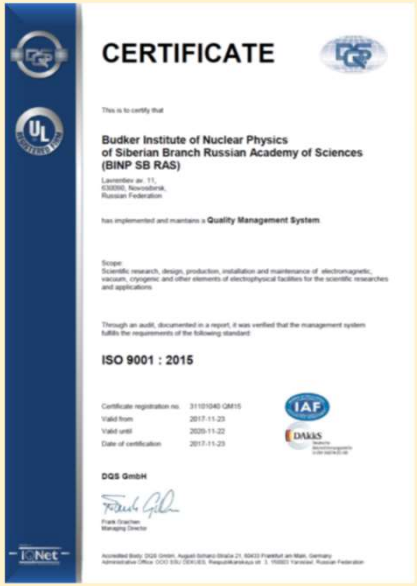



+ Siberian Synchrotron and Terahertz Radiation Centre

+ Novosibirsk Free Electron Laser, terahertz range (NovoFEL)

# BINP Experimental Workshop

+ Three sites with total area of $60000\ \mathrm{m}^2$
+ More than 100 technological divisions
+ More than 400 processing units



CERTIFICATE

Budker Institute of Nuclear Physics
of Siberian Branch Russian Academy of Sciences
(BINP SB RAS)

Lavrentiev av. 11,
630090, Novosibirsk,
Russian Federation

has implemented and maintains a Quality Management System

Scope:
Scientific research, design, production, installation and maintenance of electromagnetic, vacuum, cryogenic and other elements of electrophysical facilities for the scientific researches and applications

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2015

Certificate registration no. 31101040 QM15
Valid from 2017-11-23
Valid until 2020-11-22
Date of certification 2017-11-23

DQS GmbH

Frank Drechsler
Managing Director

# Product groups
(incomplete...)

Magnets

PS and electronics

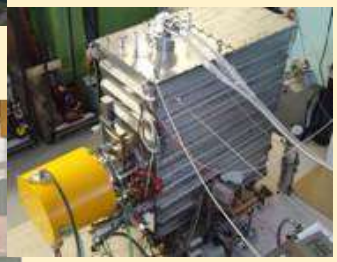
Compact neutron source

Industrial
e- accelerators

SC wigglers

Undulators

AMS



MW ion source

High vacuum systems

BNCT

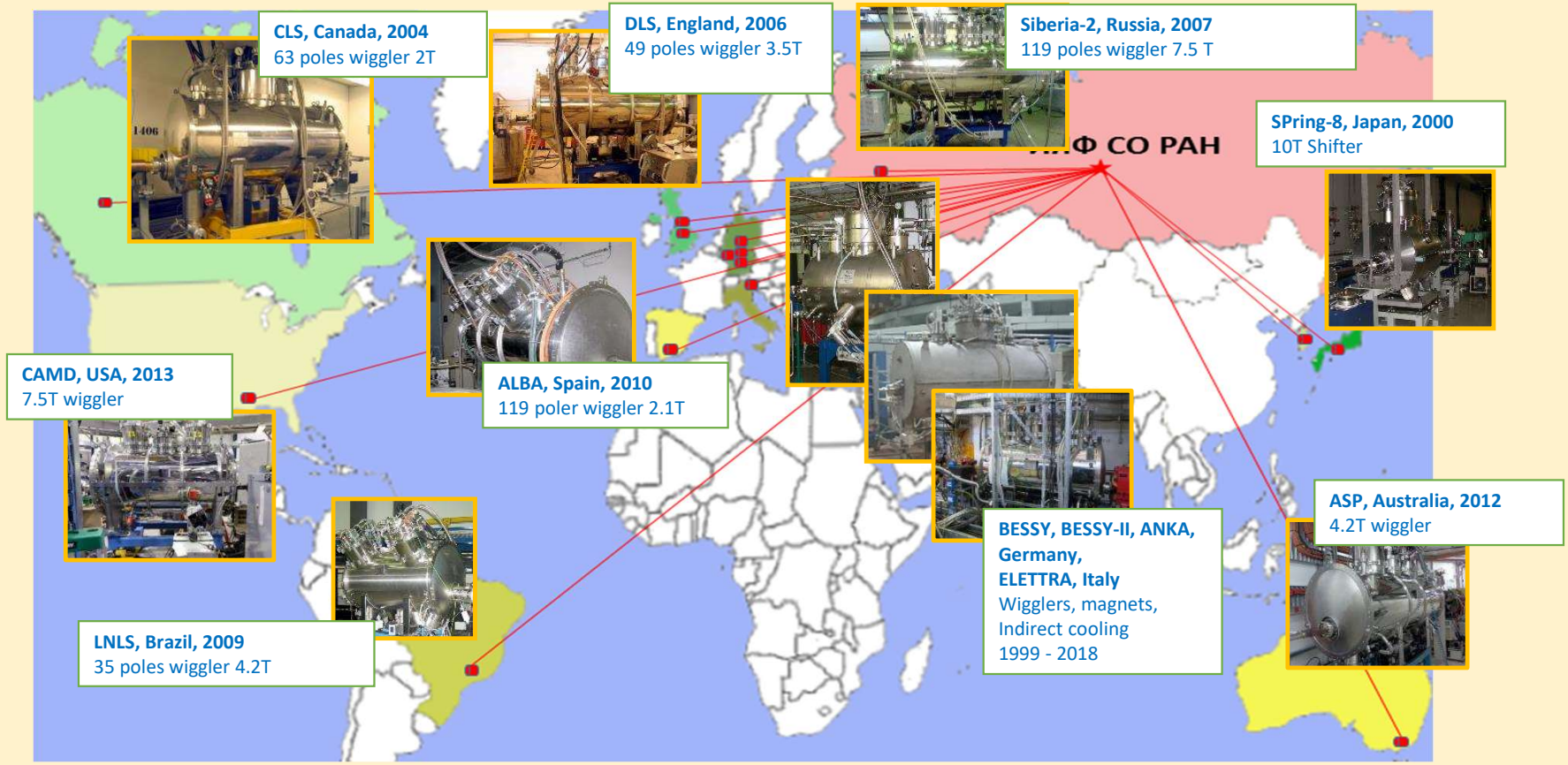
X-ray scanners

e- cooler

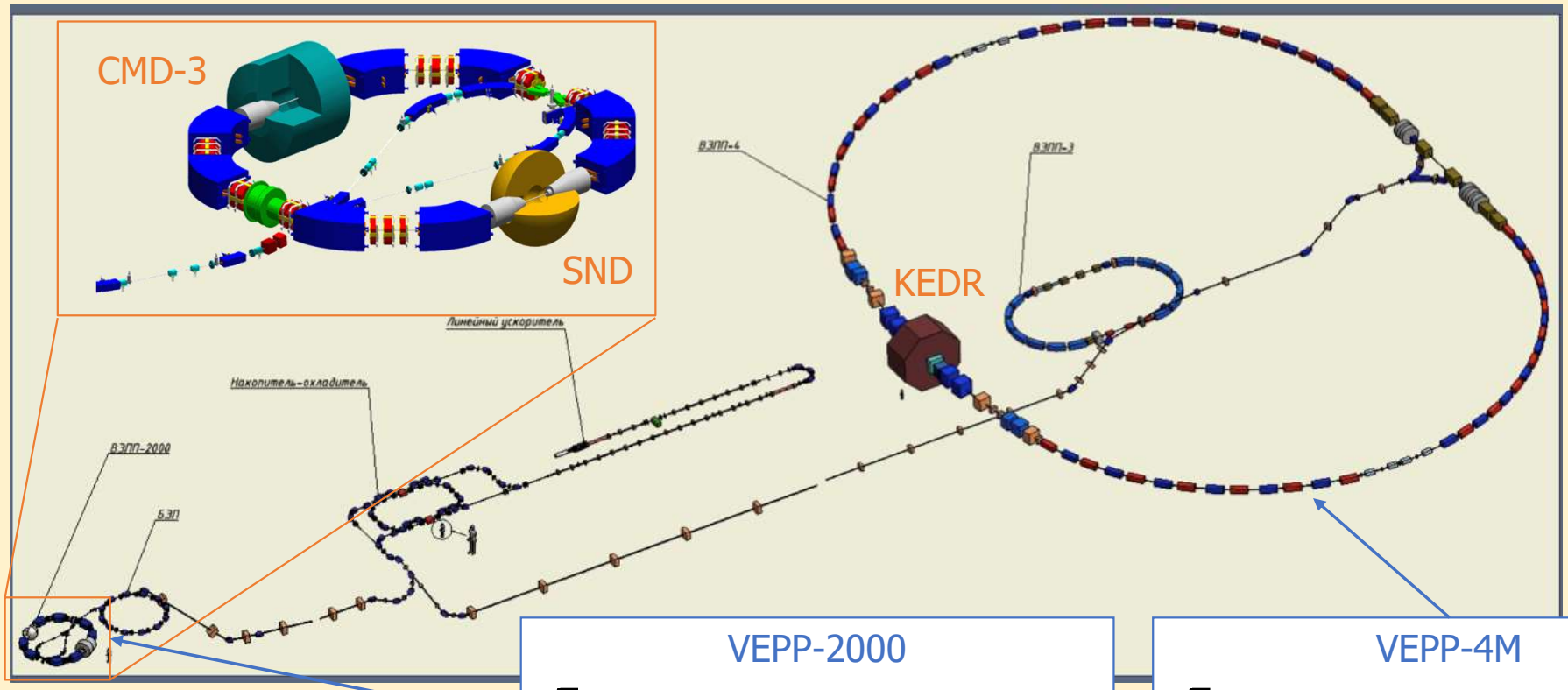
RF systems

Turn-key facilities

# Insertion devices for SR. Made in BINP



# $e^+e^-$ colliders in BINP today




**VEPP-2000**

$\sqrt{s}$ from 0.3 to 2 GeV

$\mathcal{L} = 5 \times 10^{31}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ @ 2 GeV

Round beams

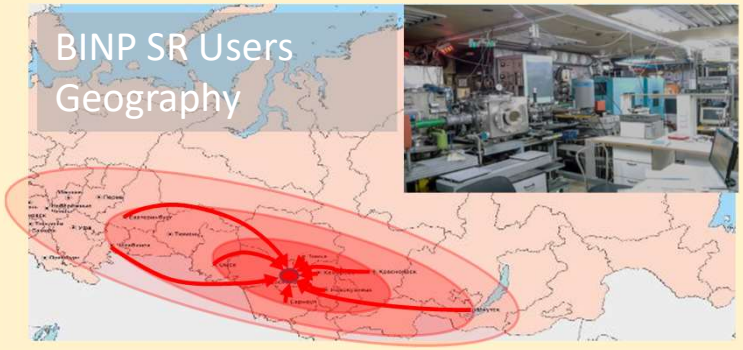
**VEPP-4M**

$\sqrt{s}$ from 2 to 10 GeV

$\mathcal{L} = 2 \times 10^{30}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ @ 2 GeV

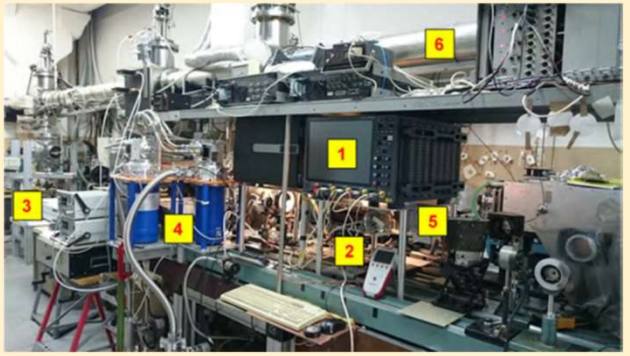
$\mathcal{L} = 8 \times 10^{31}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ @ 10 GeV

# Synchrotron radiation @ VEPP-3 and VEPP-4M and NovoFEL




**NovoFEL 2020 statistics**

- 11 user stations
- Total operation: 2220 hours
- Users at stations: 1137 hours
- Collaboration with 15 organizations



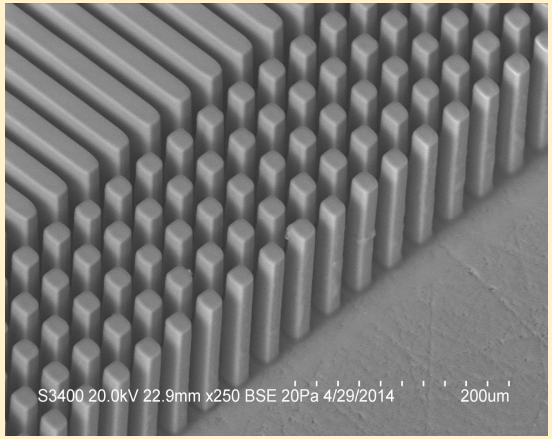

**SR Usage time (hours)**

| | Energy | 2019 | 2020 |
|---|---|---|---|
| VEPP-3 | 1.2 GeV | 205 | 60 |
| | 2.0 GeV | 750 | 540 |
| VEPP-4M | 1.9 GeV | 170 | 84 |
| | 4.5 GeV | 620 | 324 |

10 user stations

**SR 2020 statistics**

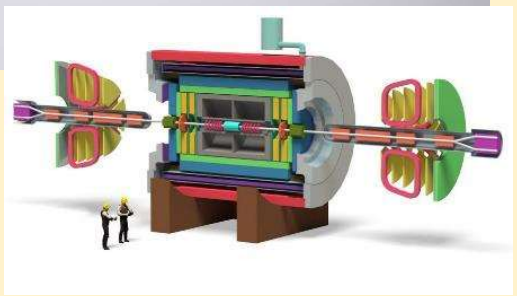
- 22 peer-review papers
- >40 proceedings
- Collaboration with 38 organizations




X-ray Lithography and LIGA-technology
indico.inp.nsk.su/event/24/contributions/1819/

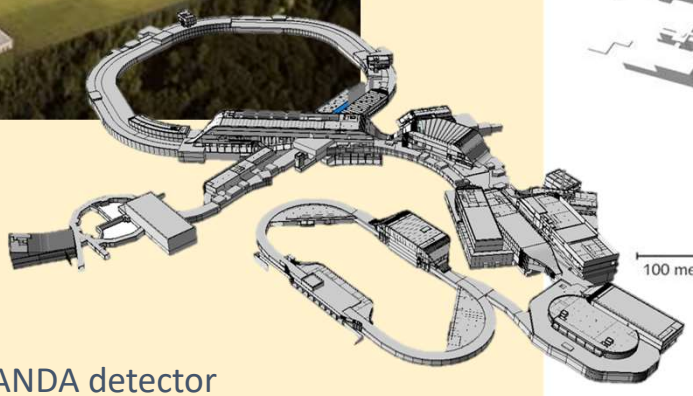
# The NICA collider at JINR

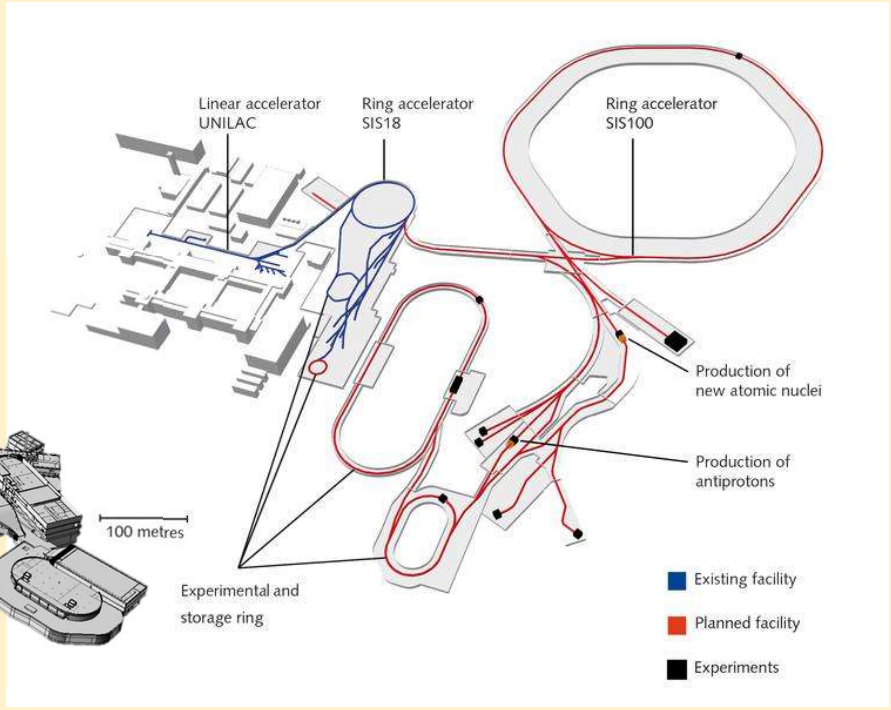
April 2017 delivery cooler from BINP to JINR

- BINP in NICA
  - RF system
  - Electronic cooling
  - Transportation channels
  - Beam dynamics, polarized beams, sensors, electronics, …

# FAIR at GSI



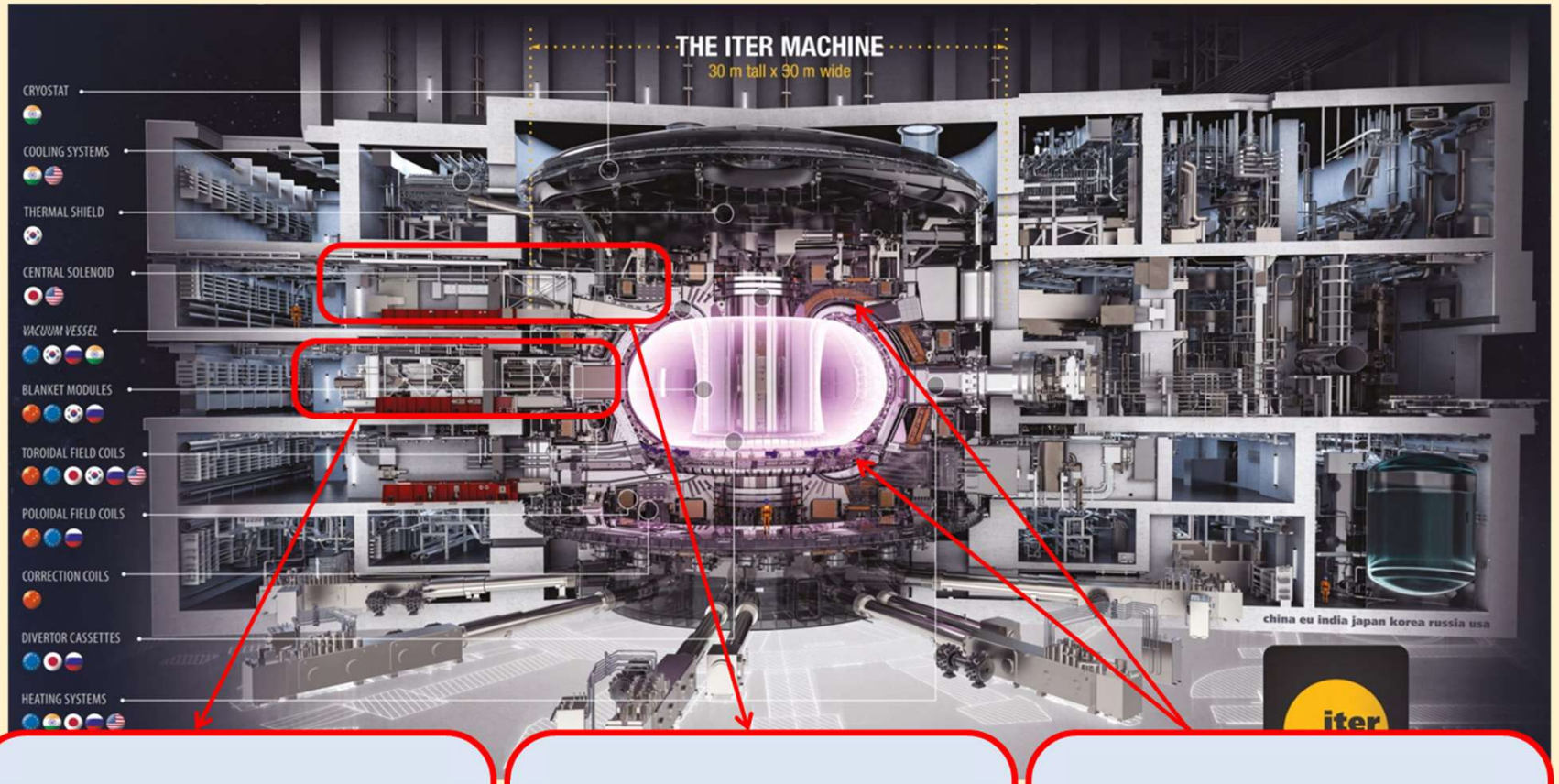



- BINP in FAIR
  - The CR Ring
  - Solenoid magnet for the PANDA detector
  - Transportation channels (vacuum and magnets)
  - Magnet for the CBM detector
- Total contracts: 82M euro till 2025

# ITER

- BINP in ITER
- Total contracts: about 15M euro till 2025 r.

- Clean assembly hall in BINP




Design, production, and integration of the equatorial port 11

Design, production, and integration of the upper ports 2, 7, 8

Design and production of the neutron diagnostics

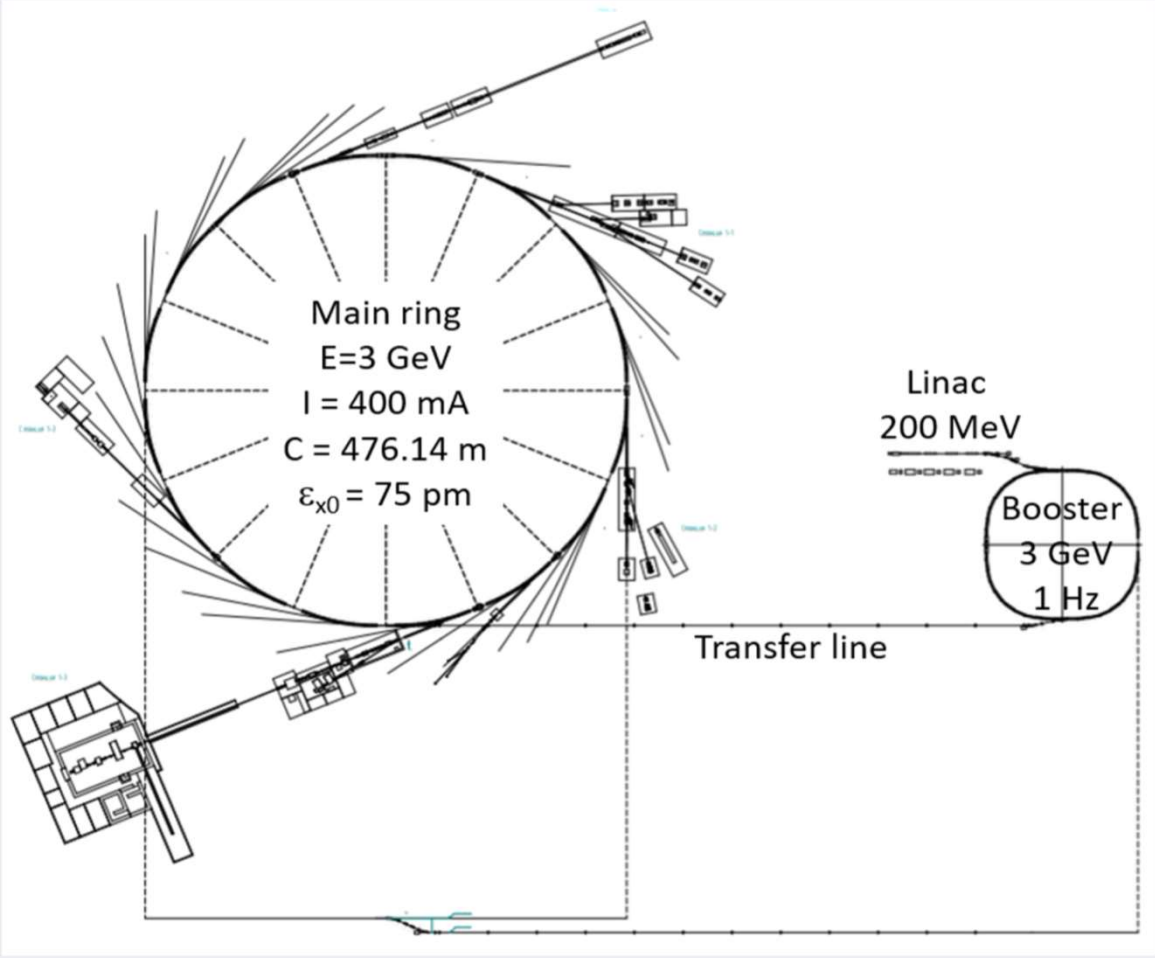
# SKIF – Siberian circular low emittance light source

- Electron's energy 3 GeV
- Current 400 mA
- Emittance 73.2 pm · rad
- Cost (w/o stations) 150 MEuro
- Launching in December 2023

# SKIF Configuration and parameters

- Linac 200 MeV
- Synchrotron-booster with 3 GeV energy and 158.7 m circumference
- 3 GeV storage ring, 16 × 6 m straight sections, 476 m orbit length, 73.2 pm natural emittance.
- ≥ 30 beamlines.

End of 2023 – first beam
End of 2024 – 6 experimental stations



# SKIF Status

- Construction and engineering design is finished
- Construction company is selected and approved by the Government
- Groundbreaking ceremony was held in September 2021
- Construction company started the site preparation
- Signed two main contracts with BINP for injector, main ring and insertion devices
- Injector production is underway, storage ring in the final design stage
- About ~70% of raw material procurement orders is signed

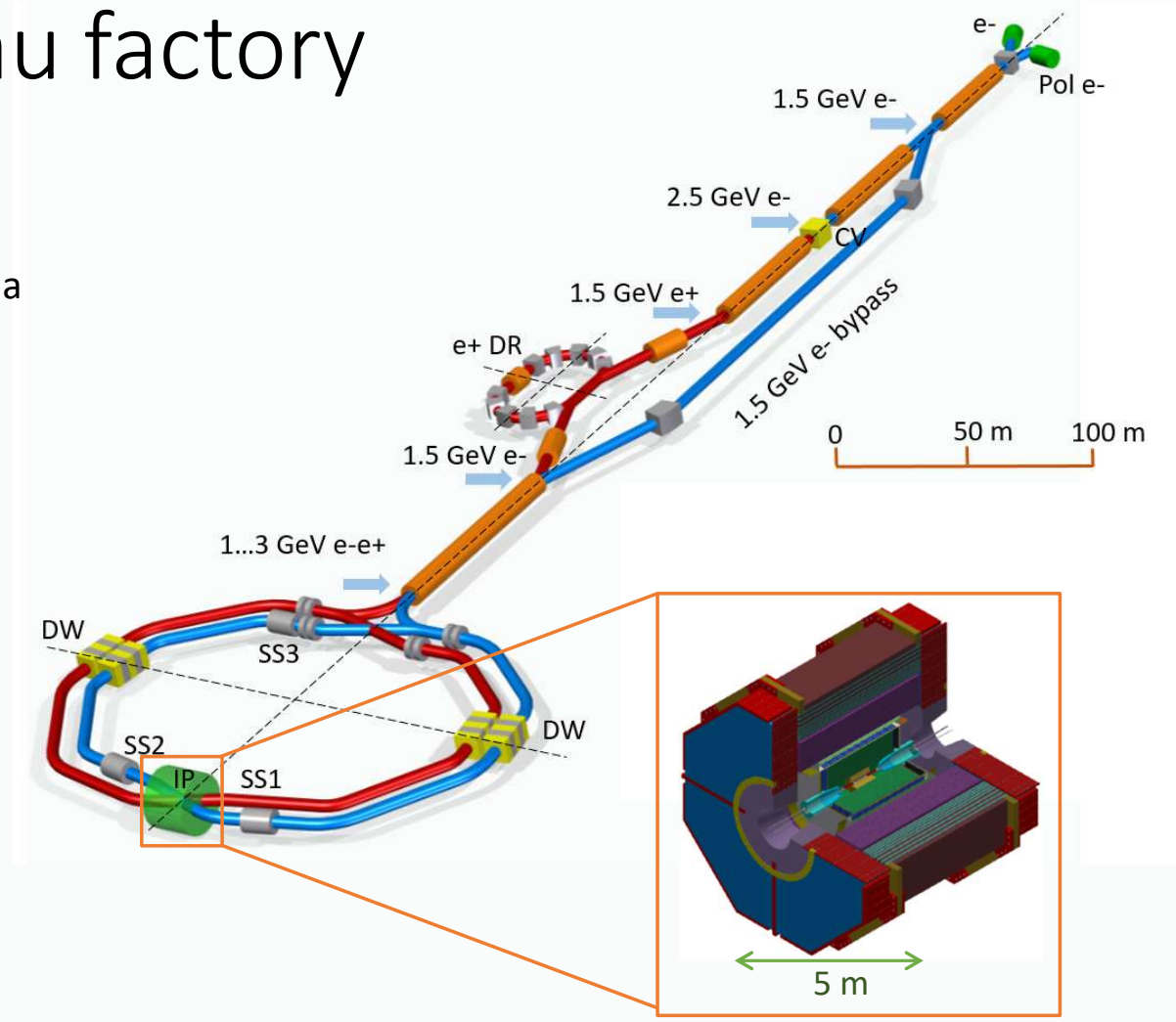






# The Super Charm-Tau factory

- Precision experiments with tau lepton and charmed hadrons, and search for BSM phenomena
- Electron-positron collider
  - Beam energy varying between $1.5$ and $3.5$ GeV
  - Luminosity $\mathcal{L} = 10^{35}\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$ @ $2$ GeV
  - Longitudinal polarization of the $e^-$ beams
- Universal particle detector
  - Tracking system
  - Crystal electromagnetic calorimeter
  - Cherenkov radiation detectors for particle identification
  - $1.5$ T superconducting solenoid
- The SCT project is being developed as *a typical mega-science project in high energy physics*

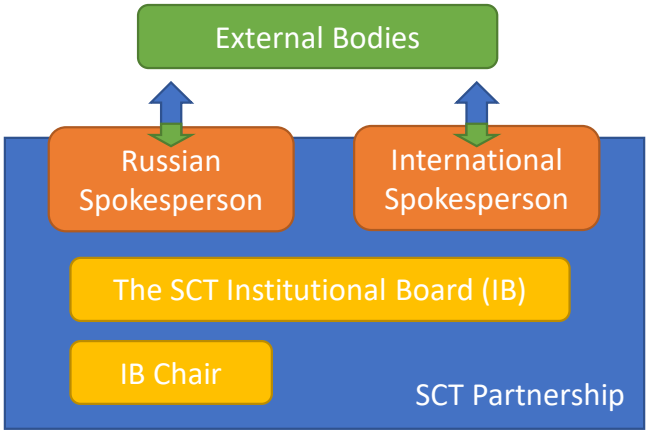


# The SCT Partnership

✓ The SCT Partnership is launched on November 18th, 2021

- The Partnership is devoted to design and promotion of the SCT experiment

1. Minimal formal structure
   - Institutional board (IB) – the main body of the Partnership
   - Two spokespersons
2. A partner is a research group
   - Only one group per organization is allowed
   - A LoI must be signed to apply to join the Partnership




Pavel Pakhlov
(LPI, HSE)
The SCT Russian Spokesperson

Ivan Logashenko
(BINP, NSU)
The SCT IB Chair

To be elected
(???)
The SCT International Spokesperson

Some participants of the 1st IB meeting
(Novosibirsk November 18th, 2021)

# Conclusions

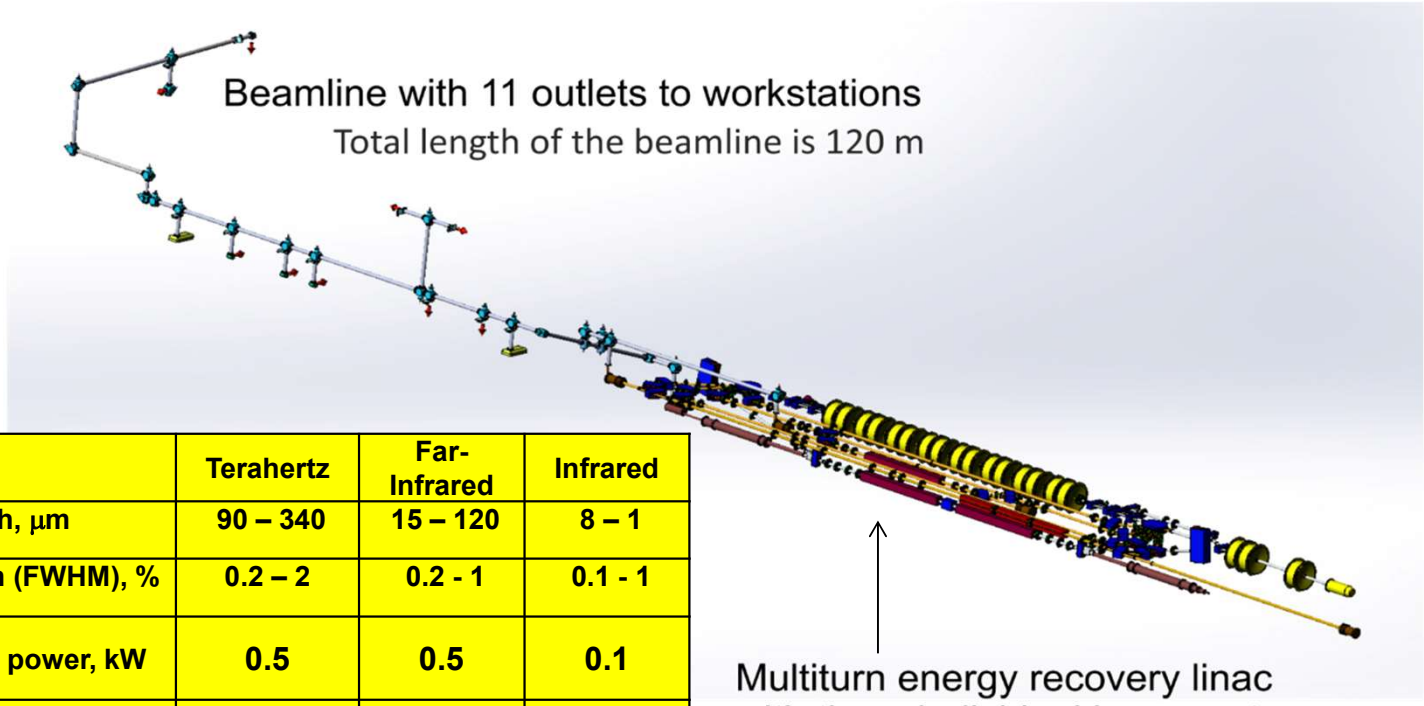
1. BINP is an active player in the national and international research infrastructure fields
2. BINP holds several RIs and contributes to many external projects


Thank you

# The SCT Partnership: founding partners

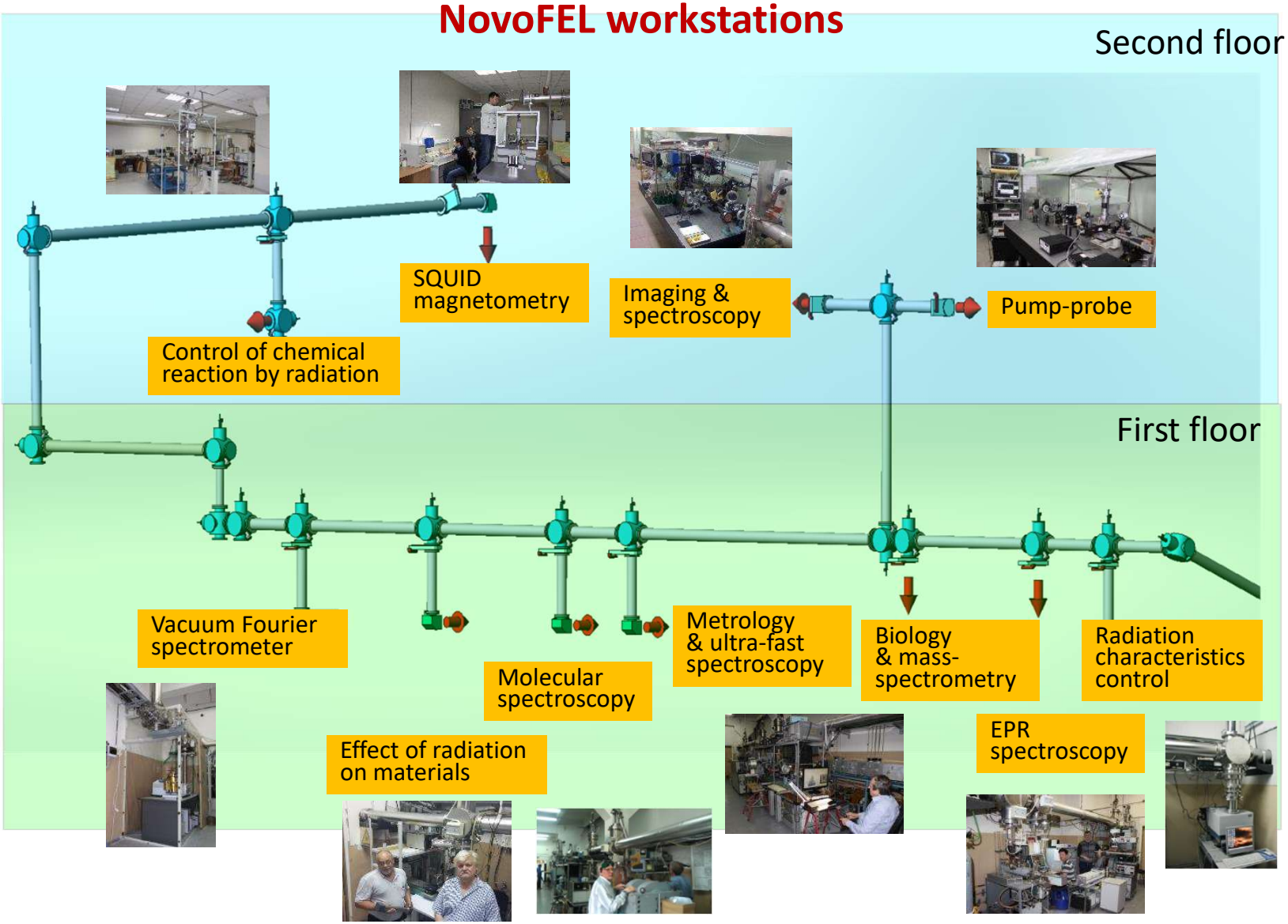
1. The JLU group (2021-09-21)
   - **Prof. Michael Düren**
   - Prof. Joybrato Mukherjee (JLU President)
2. The NSTU group (2021-09-24)
   - **Dr. Alexander Barnyakov**
   - Prof. Anatoly Bataev (NSTU Rector)
3. The NSU group (2021-10-11)
   - **Prof. Alex Bondar**
   - Prof. Mikhail Fedoruk (NSU Rector)
4. The BINP group (2021-10-13)
   - **Dr. Ivan Logashenko**
   - Dr. Pavel Logachev (BINP Director)
5. The LPI group (2021-10-14)
   - **Dr. Pavel Pakhlov**
   - Dr. Nikolay Kolachevsky (LPI Director)
6. The SINP group (2021-10-29)
   - **Prof. Eduard Boos (SINP Director)**
7. The HSE group (2021-11-15)
   - **Prof. Tagir Aushev**
   - **Dr. Andrey Ustyuzhanin**
   - Dr. Nikita Anisimov (HSE Rector)
8. The JINR group (2021-11-17)
   - **Dr. Alexey Zhemchugov**
9. The BIRP VNIIEF group (2021-11-16)
   - **Dr. Nikolay Zavyalov (BIRP Director)**
10. The Cinvestav group (2021-11-12)
    - **Prof. Eduard De La Cruz Burelo**
    - Prof. Gabriel López Castro (Cinvestav Academic Vicepresident)

**Novosibirsk FEL user facility** has three FELs, installed on the first, second and fourth orbits of the dedicated energy recovery linac (ERL). These FELs are the world's most powerful (in terms of average power) sources of coherent narrow-band (less than 1%) radiation in their wavelength ranges. The Novosibirsk ERL is the first multiturn ERL in the world. The facility has been operating for users of terahertz radiation since 2004. It is one of the partners of FELs of Europe collaboration.

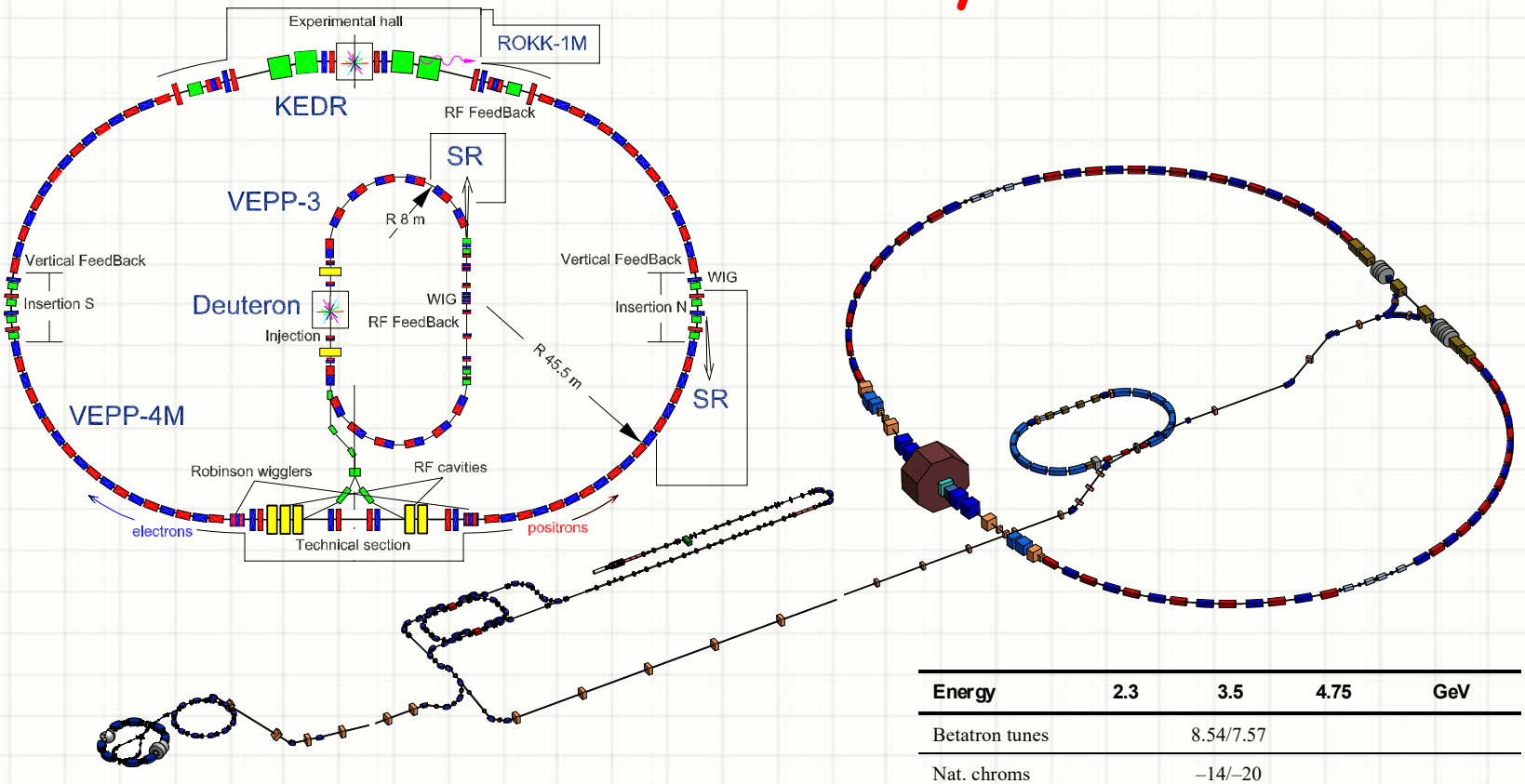



| Laser | Terahertz | Far-Infrared | Infrared |
|---|---|---|---|
| Wavelength, μm | 90 – 340 | 15 – 120 | 8 – 1 |
| Relative line width (FWHM), % | 0.2 – 2 | 0.2 - 1 | 0.1 - 1 |
| Maximum average power, kW | 0.5 | 0.5 | 0.1 |
| Maximum peak power, MW | 0.5 | 2.0 | 10 |
| Pulse duration, ps | 30 - 120 | 20 - 40 | 10 - 20 |
| Pulse repetition rate, MHz | 2.8 - 5.6 - 11.2 - 22.4 | | |

# NovoFEL workstations



# VEPP-4 facility

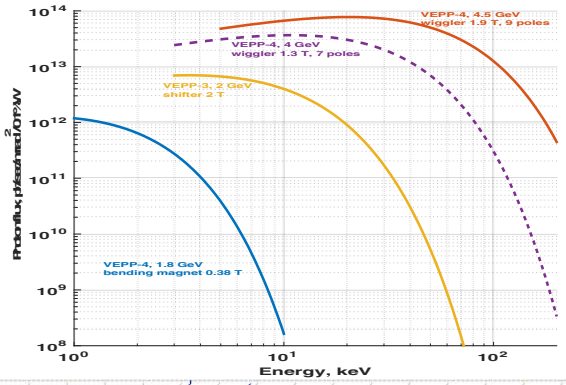


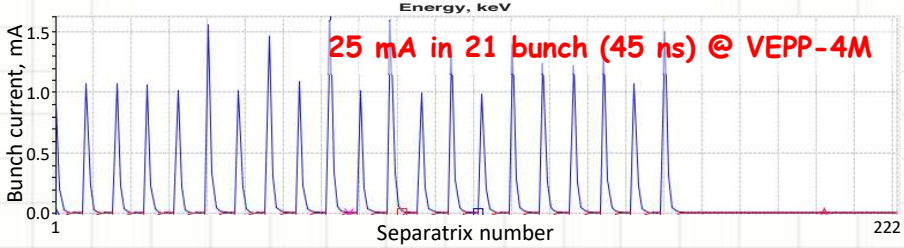

- ★ High energy physics at VEPP-4M with detector KEDR
- ★ Synchrotron radiation at VEPP-3 & VEPP-4M
- ★ Nuclear physics at VEPP-3 with Deuteron facility
- ★ Test beam facility at VEPP-4M
- ★ Accelerator physics activity

| Energy | 2.3 | 3.5 | 4.75 | GeV |
|---|---|---|---|---|
| Betatron tunes | | 8.54/7.57 | | |
| Nat. chroms | | –14/–20 | | |
| Comp. factor | | 0.0168 | | |
| Hor. emit. | 42 | 100 | 180 | nm·rad |
| Energy spread | 3.7 | 6.5 | 7.5 | $\cdot 10^{-4}$ |
| Bunch length | | 4 | | cm |
| Beam | 2x2 | 2x2 | 1x1→2x2 | |
| Bunch current | 6 | 9→12 | 9→12 | mA |
| Luminosity | 0.5 | 1.2→2.0 | 0.5→1.4 | $\cdot 10^{31}$ cm$^{-2}$ s$^{-1}$ |

# Synchrotron radiation

| | VEPP-3, 74 m | | VEPP-4M, 366 m | | |
|---|---|---|---|---|---|
| | 1.2 GeV | 2 GeV | 1.9 GeV | 2.5 GeV | 4.5 GeV |
| | 100 nm·rad | 290 nm·rad | 28 nm·rad | 50 nm·rad | 160 nm·rad |
| | 200 mA @ 1÷2 bunches | | 25 mA @ 1÷25 bunches | | |
| 1 | LIGA-technology and X-ray lithography. | | Metrology experiments. | | |
| 2 | Fast dynamic process. | | Phase contrast microscopy, micro-tomography and hard X-ray fluorescence. | | |
| 3 | Precise diffraction and anomalous scattering. | | Nanosecond spectroscopy of fast processes. | | |
| 4 | X-ray fluorescence analysis. | | Material study under extremal conditions | | |
| 5 | High pressure diffraction. | | Material study for thermonuclear applications | | |
| 6 | X-ray microscopy and micro-tomography. | | | | |
| 7 | Time resolved diffraction. | | | | |
| 8 | Time resolved luminescence. | | | | |
| 9 | Precise diffraction. | | | | |

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Russian Text © The Author(s), 2020, published in Poverkhnost', 2020, No. 2, pp. 34–38.

## Experiments with Synchrotron Radiation at the VEPP-4M

G. Baranov[a], V. Borin[a, b], A. Zhuravlev[a], K. Zolotarev[a], S. Karnaev[a], K. Kuper[a], E. Levichev[a], O. Meshkov[a, b], S. Mishnev[a], I. Nikolaev[a], A. Nikolenko[a], and P. Piminov[a, *]
[a]Budker Institute of Nuclear Physics, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 630090 Russia
[b]Novosibirsk State University, Novosibirsk, 630090 Russia
*e-mail: piminov@inp.nsk.su
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Russian Text © The Author(s), 2020, published in Poverkhnost', 2020, No. 12, pp. 50–53.

## Hybrid Nine-Pole Wiggler as a Source of "Hard" X-ray Radiation at the VEPP-4 Accelerator Complex

G. H. Baranov[a, b, *], K. E. Cooper[a], P. A. Piminov[a], P. D Vobly[a], A. A. Legkodymov[a], L. I. Shekhtman[a], A. N. Shmakov[c], and E. B. Levichev[a]
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